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A METHOD OF CALCULATING ECONOMICAL BALANCED RATIONS.

By J. C. RUNDLES, *Scientific Assistant.*

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Economy in feeding is of prime importance to the feeder. It involves judgment in the selection of feeds as well as skill in the mixing of rations. The feeder may know that he needs a concentrate rich in carbohydrates or one rich in protein, yet be at a loss to determine the cheapest form of the desired concentrate to buy. Again, he may have certain feeds available and be unable to determine the most economical proportion in which they should be fed to give a ration of a desired nutritive ratio. This bulletin suggests ways in which these problems may be solved by fixed rule as they arise.

It is, of course, generally understood among students of nutrition that protein, carbohydrate, and fat content of a feeding stuff is not the only factor affecting its feed value. Proteins differ in their nutritive qualities, while some substances not included in the classes above mentioned are necessary to the proper maintenance of the bodily functions. The palatability and succulence of a feeding stuff has much to do with its value as a feed. Many feeding stuffs have physiological effects entirely apart from their nutritive qualities. Again, a ration may be perfectly balanced from the standpoint of relative content of protein and energy producers, and yet be quite impracticable because too bulky or too concentrated. It is therefore understood that any consideration of a feeding stuff or a ration

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based only on chemical composition is to be taken merely as a guide, to be followed in the light of all the knowledge obtainable about animal nutrition.

NEW METHOD OF BALANCING RATIONS.

The method of balancing rations commonly used might well be called the "Cut and Try Method." It is faulty for the reason that it usually necessitates several trials to secure the desired result. By using the method described in these pages, balancing a ration is a simple matter of multiplication and division.[1]

Table I gives the excess protein per pound for different protein feeds when used in rations of various nutritive ratios. To illustrate: A hundred pounds of dried brewer's grains contains 21.5 pounds digestible protein and 44.2 pounds digestible carbohydrates. A ration with a nutritive ratio of 1:4, requires only 11.05 pounds protein to balance 44.2 pounds of carbohydrates. Hence, in such a ration, 100 pounds of this feed contains 21.5 − 11.05, or 10.45 pounds of excess protein. The excess protein in a single pound is thus 0.1045 pound. (See Table I, column headed "Ratio 1 to 4," opposite brewer's grains, dried.) In rations having wider ratios the excess protein is proportionally greater.

Some of the figures in Table I are printed in italics. These represent deficiency instead of excess in protein. Thus, in a ration of ratio 1:4, a pound of rye is deficient in protein by 0.0798 pound, while in a ration of ratio 1:10, it has an excess of protein amounting to 0.0279 pound.

In like manner Table II shows the protein deficiency per pound for various carbohydrate feeds as compared with rations of specified nutritive ratios. The italic figures in this table represent excess protein. Thus, in a ration of ratio 1:4, a pound of buckwheat is deficient in protein by 0.0572 pound, while in a ration with ratio 1:10 it has an excess of 0.0257 pound of protein.

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[1] The tables used in this bulletin are based upon Table III, Digestible nutrients and fertilizing constituents, in Henry's "Feeds and Feeding." It was necessary to include the digestible fat, with its equivalent fuel value ($2\frac{1}{4}\times$carbohydrate) with the carbohydrate in order to prepare the tables. In proposing a mathematical method for balancing rations different from the one commonly employed, the same assumptions are made as in the case of the usual method, viz, that fats have two and one-fourth times the feeding value of the carbohydrates and that a pound of carbohydrates or protein has a uniform value whatever its source. The latter assumption is, of course, not strictly true. Proteins differ somewhat in their nutritive value, and sugars have nutritive and physiological effects somewhat different from those of starches. Nevertheless, the assumption of the equality of value of these nutritive elements in various feed stuffs introduces a no greater source of error in the method proposed in this bulletin than in the usual method of balancing rations.

The method of balancing rations described in this bulletin is based on the principle (alligation) proposed by Prof. J. T. Willard in Kansas Experiment Station Bulletin 115, but the method of applying this principle is different, and is believed to be simpler and more convenient, especially when several feeding stuffs are to be used in the ration.

TABLE I.—*The amount of excess protein per pound of given protein feeds when used in rations with the following specified nutritive ratios.*

Protein feeds.	Digestible—		Nutritive ratio 1.	Ratio 1 to 4.	Ratio 1 to 5.	Ratio 1 to 6.	Ratio 1 to 7.	Ratio 1 to 8.	Ratio 1 to 9.	Ratio 1 to 10
	Protein, per 100 lbs. feed.	Carbohydrate, per 100 pounds feed.[1]								
I. Concentrates:										
Brewers' grains, dried	21.5	44.2	2.1	0.1045	0.1266	0.1413	0.1519	0.1597	0.1659	0.1708
Cottonseed meal, choice	37.0	41.2	1.1	.2670	.2876	.3013	.3111	.3185	.3242	.3288
Cottonseed meal, good	31.6	43.2	1.4	.2080	.2296	.2440	.2543	.2620	.2680	.2728
Cowpea seed	19.4	57.0	2.9	.0515	.080	.099	.1126	.1227	.1307	.1370
Distillers' grains, dry, corn	22.4	66.5	3.0	.0578	.091	.1132	.1290	.1409	.1501	.1575
Distillers' grains, dry, rye	13.6	52.8	3.9	.004	.0304	.088	.0606	.07	.0773	.0832
Dried blood	69.1	2.0	.03	.6360	.6870	.6876	.6881	.6885	.6888	.6890
Fish meal, high in fat	37.8	26.1	.7	.3128	.3258	.3345	.3407	.3454	.3490	.3519
Fish meal, low in fat	40.9	5.0	.1	.3965	.3990	.4007	.4019	.4028	.4034	.4040
Germ oil meal, (H. G.)	15.5	66.0	4.0	.....	.033	.055	.0707	.0825	.0917	.099
Gluten feed (H. G.)	21.6	59.1	2.7	.0682	.0978	.1175	.1316	.1421	.1503	.1569
Gluten feed (L. G.)	15.1	68.6	4.5	*.0205*	.0118	.0367	.053	.0653	.0748	.0824
Linseed meal (N. P.)	31.7	44.2	1.4	.2065	.2286	.2433	.2539	.2617	.2679	.2728
Linseed meal (O. P.)	30.2	47.7	1.6	.1828	.2066	.2225	.2339	.2424	.2490	.2543
Malt sprouts	20.3	50.3	2.5	.0772	.1024	.1192	.1311	.1401	.1471	.1527
Meat and bone meal, 30–40 per cent ash	37.0	24.8	.7	.3080	.3204	.3286	.3346	.3390	.3424	.3452
Meat and bone meal, over 40 per cent ash	30.9	22.1	.7	.2538	.2648	.2722	.2774	.2814	.2844	.2869
Peanuts with hulls	18.4	88.7	4.8	*.0378*	.0066	.0362	.0573	.0731	.0854	.0953
Peanut cake from hulled nuts	42.8	36.6	.9	.3365	.3548	.3670	.3757	.3823	.3873	.3914
Rye	9.8	71.1	7.2	*.0798*	*.0442*	*.0200*	*.0036*	.01	.02	.0279
Rye middlings	12.6	62.5	5.0	*.0302*	.001	.0218	.0367	.0479	.0565	.0635
Soy-bean seed	30.7	55.2	1.8	.1690	.1966	.2150	.2281	.2380	.2457	.2518
Tankage, 55–60 per cent	54.0	28.6	.5	.4685	.4828	.4923	.4991	.5042	.5082	.5112
Tankage, 45–55 per cent	48.0	30.8	.6	.4030	.4184	.4287	.4360	.4415	.4458	.4492
Tankage, below 45 per cent ash	37.6	37.6	1.0	.2820	.3008	.3133	.3223	.3290	.3342	.3384
Velvet-bean seed	18.1	62.7	3.5	.0242	.0556	.0765	.0914	.1026	.1113	.1183
Wheat flour middlings	15.7	62.5	4.0	.0008	.032	.0529	.0677	.0789	.0875	.0945
Wheat bran, winter	12.2	47.4	3.9	.0035	.0272	.043	.0543	.0627	.0693	.0746
Wheat shorts, standard, wheat middlings	13.4	55.9	4.2	*.0058*	.0222	.041	.0541	.0641	.0719	.0781
II. Roughage:										
Alfalfa hay	10.6	41.0	3.9	.0035	.024	.0376	.0474	.0547	.0604	.065
Alfalfa meal	10.2	40.5	4.0	.0008	.021	.0345	.0441	.0514	.057	.0615
Clover hay, alsike, all analyses	7.9	39.4	5.0	*.0195*	.0002	.0133	.0227	.0298	.0352	.0396
Clover hay, crimson	9.7	39.0	4.0	*.0005*	.019	.032	.0413	.0482	.0537	.058
Clover hay, red, all analyses	7.6	43.3	5.7	*.0322*	*.0106*	.0038	.0141	.0219	.0279	.0327
Clover hay, sweet, yellow	10.0	37.0	3.7	.0075	.026	.0383	.0471	.0538	.0588	.063
Clover hay, sweet, white	10.9	39.8	3.7	.0095	.0294	.0427	.0521	.0592	.0648	.0692
Cowpea hay, all analyses	13.1	35.9	2.7	.0412	.0592	.0712	.0797	.0861	.0911	.0951
Molasses alfalfa feeds	8.5	42.1	5.0	*.0202*	.0008	.0148	.0249	.0324	.0382	.0429
Peanut-vine hay with shells	9.6	58.3	6.1	*.0498*	*.0206*	*.0012*	.0127	.0231	.0312	.0377
Peas and oat hay	8.3	40.5	4.9	*.0182*	.002	.0155	.0251	.0324	.038	.0425
Skim milk, centrifugal	3.6	5.5	1.5	.0223	.025	.0268	.0281	.0291	.0299	.0305
Soy bean hay	11.7	41.9	3.6	.0122	.0332	.0471	.0571	.0646	.0704	.0751
Velvet bean hay	12.0	43.5	3.6	.0112	.033	.0475	.0579	.0656	.0717	.0765
Vetch hay	11.6	46.4	4.0	.....	.0232	.0387	.0497	.058	.0644	.0696

[1] The carbohydrate includes the fat with its usual fuel value (2½ times carbohydrate in Tables V and VI). Reference: Table III, Digestible nutrients and fertilizing constituents, Henry's "Feeds and Feeding."

The use of Tables I and II in balancing rations is illustrated in the following examples:

1. How much cottonseed meal is required to balance a dairy ration consisting of 30 pounds corn silage, 10 pounds alfalfa hay, and 3 pounds corn meal, giving a nutritive ratio of 1:6?

Solution:

	Protein.	
	Excess.	Deficiency.
30 pounds corn silage		0.5010
10 pounds alfalfa hay	0.3760	
3 pounds corn meal		.1776
	.3760	.6786
Subtracting		.3760
1 pound cottonseed meal, excess	.3013	.3026
Pounds cottonseed meal required		1

TABLE II.—*The amount of protein deficiency per pound of given carbohydrate feeds in rations with the following specified nutritive ratios.*

Carbohydrate feeds.	Digestible—		Nutritive ratio 1.	Ratio 1 to 4.	Ratio to 5.	Ratio 1 to 6.	Ratio 1 to 7.	Ratio 1 to 8.	Ratio 1 to 9.	Ratio 1to10.
	Protein.	Carbohydrate.								
I. Concentrates:										
Barley	9.0	70.4	7.8	0.086	0.0508	0.0273	0.0106	*0.002*	*0.0118*	*0.0196*
Beet pulp, dry	4.6	67.0	14.6	.1215	.088	.0657	.0497	.0377	.0284	.021
Broom-corn seed	8.3	68.7	8.3	.0888	.0544	.0315	.0151	.0029	*.0067*	*.0143*
Buckwheat	8.1	55.3	6.8	.0572	.0296	.0112	*.002*	*.0119*	*.0196*	*.0257*
Corn meal, chop, or shelled corn	6.9	76.9	11.1	.1232	.0848	.0592	.0409	.0271	.0164	.0079
Corn and cob meal	6.1	72.0	11.8	.1190	.083	.059	.0419	.029	.019	.011
Corn, oat, and barley feed	9.1	68.9	7.6	.0812	.0468	.0238	.0074	*.0049*	*.0144*	*.0221*
Durra grain	8.2	74.0	9.0	.1030	.066	.0413	.0237	.0105	.0002	*.0080*
Germ oil meal (L. G.)	10.0	72.8	7.3	.082	.0456	.0213	.004	*.009*	*.0191*	*.0272*
Hominy feed (H. G.)	7.0	77.6	11.1	.1240	.0852	.0593	.0409	.027	.0162	.0076
Hominy feed (L. G.)	6.3	76.7	12.2	.1288	.0904	.0648	.0466	.0329	.0222	.0137
Kafir grain	9.0	71.0	7.9	.0875	.052	.0283	.0114	*.0012*	*.0111*	*.0190*
Milo grain	8.7	71.2	8.2	.0910	.0554	.0317	.0147	.002	*.0079*	*.0158*
Molasses feeds, below 10 per cent fiber	8.2	58.4	7.1	.064	.0348	.01533	.0014	*.009*	*.0171*	*.0236*
Molasses feeds, 10–15 per cent fiber	7.4	57.1	7.7	.0688	.0402	.0212	.0076	*.0026*	*.0106*	*.0169*
Molasses or blackstrap	1.0	58.2	58.2	.1355	.1064	.0870	.0731	.0628	.0547	.0482
Oats, ground (H. G.)	9.4	60.6	6.4	.0575	.0272	.007	*.0074*	*.0182*	*.0267*	*.0334*
Oats	9.7	60.7	6.3	.0548	.0244	.0042	*.0103*	*.0211*	*.0296*	*.0363*
Rice, polished	8.0	74.1	9.3	.1052	.0682	.0435	.0259	.0126	.0023	*.0059*
Rice, rough	4.7	68.4	14.6	.1240	.0898	.067	.0507	.0385	.029	.0214
Rice bran (H. G.)	7.9	57.9	7.3	.0658	.0368	.0175	.0037	*.0066*	*.0147*	*.0211*
Rye	9.9	71.1	7.2	.0788	.0432	.0195	.0026	*.0101*	*.0200*	*.0279*
Rye meal	9.2	70.5	7.7	.0843	.049	.0255	.0087	*.0039*	*.0137*	*.0215*
Sorghum grain	7.5	72.0	9.6	.1050	.069	.045	.0279	.015	.005	*.003*
Wheat, winter	8.7	71.0	8.2	.0905	.055	.0314	.0144	.0018	*.0081*	*.0160*
II. Roughages:										
Blue grass, Kentucky, all analyses	2.3	16.2	7.0	.0175	.0094	.004	.0001	*.0028*	*.005*	*.0068*
Corn fodder, medium in water	3.0	50.7	16.9	.0968	.0714	.0545	.0424	.0334	.0263	.0207
Corn silage, well matured	1.1	16.6	15.1	.0305	.0222	.0167	.0127	.0098	.0074	.0056
Corn and clover silage	2.1	17.5	8.3	.0228	.014	.0082	.004	.0009	*.0016*	*.0035*
Corn stover, green, ears off	.5	12.4	24.8	.026	.0198	.0157	.0127	.0105	.0088	.0074
Kafir fodder, dry	4.1	48.8	11.9	.081	.0566	.0403	.0287	.02	.0132	.0078
Milo fodder, dry	1.9	42.6	22.4	.0875	.0662	.052	.0419	.0342	.0283	.0236
Millet, German	4.8	53.5	11.1	.0858	.059	.0412	.0284	.0189	.0114	.0055
Molasses-alfalfa feeds	8.5	42.1	5.0	.0203	*.0008*	*.0148*	*.0249*	*.0324*	*.0382*	*.0429*
Oat hay	4.5	41.9	9.3	.0598	.0388	.0248	.0149	.0074	.0016	*.0031*
Oat straw	1.0	44.6	44.6	.1015	.0792	.0643	.0537	.0458	.0396	.0346
Sorghum and cowpea silage	.9	18.0	20.0	.036	.027	.021	.0167	.0135	.011	.009
Sorghum dry fodder	2.8	49.3	17.6	.0953	.0706	.0542	.0424	.0336	.0268	.0213
Sweet sorghum, green	.7	15.5	22.1	.0318	.024	.0188	.0151	.0124	.0102	.0085
Sweet-corn fodder	5.9	50.5	8.6	.0673	.042	.0252	.0131	.0041	*.0029*	*.0085*
Soy beans and corn	1.7	15.0	8.8	.0205	.013	.008	.0044	.0018	*.0003*	*.0020*
Timothy hay, all analyses	3.0	45.5	15.2	.0838	.061	.0458	.035	.0269	.0206	.0155
Timothy and clover	4.0	42.2	10.6	.0655	.0444	.0303	.0203	.0128	.0069	.0022
Wheat hay	4.0	50.3	12.6	.0858	.0606	.0438	.0319	.0229	.0159	.0103
Wheat straw	.7	36.2	51.7	.0835	.0654	.0533	.0447	.0383	.0332	.0292

The excess or deficiency in protein of each feeding stuff in the above example is found first for one pound, in Table I or II, in the column headed "Ratio 1 to 6." The figures given in the table are then multiplied by the number of pounds of the respective feeding stuffs in the ration. Thus, in a ration with a 1:6 ratio, a pound of corn silage is deficient in protein to the extent of 0.0167 pound. (See Table II, column headed "Ratio 1 to 6," line beginning "Corn silage, well matured.") There being 30 pounds of silage, the total protein deficiency in silage is $0.0167 \times 30 = 0.5010$ pound. Subtracting the excess protein in 10 pounds of alfalfa (0.376 pound), the net deficit of protein is found to be 0.3026 pound. Dividing this by the excess protein in one pound of cottonseed meal, which is 0.3013 pound, we find that it takes almost 1 pound of the latter to balance the ration to a 1 to 6 ratio. After adding this pound of cottonseed meal, the balanced ration stands as follows:

	Protein.	
	Excess.	Deficiency.
30 pounds corn silage		0.5010
10 pounds alfalfa hay	0.3760	
3 pounds corn meal		.1776
1 pound cottonseed meal	.3013	
	.6773	.6786

Sometimes it may be desirable to balance a ration, not simply by adding a protein feeding stuff, but by substituting it for one less rich in protein. Suppose, for instance, that we desire to substitute enough cottonseed meal for corn meal in the above ration to make the nutritive ratio 1 to 6. In this case the ration is worked out as follows:

	Protein.	
	Excess.	Deficiency.
30 pounds corn silage		0.5010
10 pounds alfalfa hay	0.3760	
3 pounds corn meal		.1776
	.3760	.6786
		.3760
Net deficiency		.3026

Taking out 1 pound corn meal reduces deficiency	0.0592
Adding 1 pound cottonseed meal reduces deficiency	.3013
Total reduction per pound substituted	.3605

Pounds to be substituted, $0.3026 \div 0.3605 = 0.84$.

Corn meal remaining after substitution, $3.00 - 0.84 = 2.16$.

The resulting ration is therefore:

	Protein.	
	Excess.	Deficiency.
30 pounds corn silage		0.5010
10 pounds alfalfa hay	0.3760	
2.16 pounds corn meal		.1279
0.84 pound cottonseed meal	.2531	
	.6291	.6289

2. When a ratio of 1:6 is desired, how much alfalfa meal is required to balance a dairy ration of 35 pounds corn silage, 4 pounds corn meal, and 2 pounds cottonseed meal?

Solution:

	Protein.	
	Excess.	Deficiency.
35 pounds corn silage		0.5845
4 pounds corn meal		.2368
2 pounds cottonseed meal	0.6026	
	.6026	.8213
		.6026
Excess protein in 1 pound alfalfa meal		0.0345) .2187
Pounds alfalfa meal required		6.3

3. In a ration for hogs it is desired to feed alfalfa meal and tankage in equal parts along with sufficient corn meal to give a nutritive ratio of 1 to 7. In what proportion should the feeding stuffs be mixed?

Solution:

	Protein excess.
1 pound tankage	0.4991
1 pound alfalfa meal	.0441
1 pound corn meal, deficiency	0.0409) .5432
Pounds corn meal required	13.3

The proportion in which to mix the feeds is, therefore, tankage 1 pound, alfalfa meal 1 pound, and corn meal 13.3 pounds.

4. In order to secure a beef-feeding ration with a ratio 1 to 8, how much good cottonseed meal should be added to a ration consisting of corn silage 21 pounds, shelled corn 14 pounds, corn, oat, barley feed 3 pounds, and alfalfa hay 3 pounds?

Solution:

	Protein.	
	Excess.	Deficiency.
21 pounds corn silage	.....	0.2058
14 pounds shelled corn	.....	.3794
3 pounds corn, oat, barley feed	0.0147	.....
3 pounds alfalfa hay	.1641	.....
	.1788	.5852
	.....	.1788
1 pound cottonseed meal, excess	.....	0.2620) .4064
Pounds cottonseed meal required	.....	1.55

HOW TO USE TABLES I AND II.

Given the desired nutritive ratio and a ration, or certain feeds in bulk to balance, proceed as follows:

(*a*) Turn to Table II. In the column representing the nutritive ratio desired find the protein deficiency for 1 pound of each of the carbohydrate feeds that are to be fed.

(*b*) For each feed multiply the protein deficiency per pound by the total quantity of that feed, add the products, and the sum is the digestible protein deficiency, or quantity required to balance the carbohydrate feeds.

(*c*) Turn to Table I. Note the amount of excess protein in 1 pound of each of the protein feeds to be fed given opposite the names of the feeds in the column representing the desired nutritive ratio.

(*d*) For each feed multiply the excess protein per pound by the total quantity of that feed, disregarding the one to be used for balancing the ration, and the sum of the products represents the total protein excess in the nitrogenous part of the feed or ration.

(*e*) Subtract the total amount of excess digestible protein furnished by the known quantity of the protein feeds from the total amount of protein required by the carbohydrate feeds and divide the difference by the excess amount of digestible protein furnished in 1 pound of the protein feed used for balancing the same.

TABLE OF EQUIVALENT PRICES.

It is often desirable in this connection to know what prices per bushel of grain correspond to hundred-weight values, and vice versa. For that reason Table III has been prepared.

TABLE III.—*Various values of grain per bushel and corresponding values per 100 pounds.*

Value per bushel.	Value per 100 pounds.							
	Wheat.	Rye.	Oats.	Barley.	Buck-wheat.	Corn, shelled.	Corn on cob.	Potatoes.
$0.20	.....	.....	$0.62	.....	.....	.....	.....	.....
.30	.....	.....	.94	.....	.....	.....	.....	.....
.40	.....	.....	1.25	$0.83	$0.83	.....	.....	$0.67
.50	.....	$0.89	1.56	1.04	1.04	$0.89	$0.73	.83
.60	$1.00	1.07	1.87	1.25	1.25	1.07	.88	1.00
.70	1.17	1.25	2.19	1.46	1.46	1.25	1.03	1.17
.80	1.33	1.43	2.50	1.67	1.67	1.43	1.18	1.33
.90	1.50	1.61	2.81	1.87	1.87	1.61	1.32	1.50
1.00	1.67	1.79	3.12	2.08	2.08	1.79	1.47	1.67
1.10	1.83	1.96	3.44	2.29	2.29	1.96	1.62	1.83
1.20	2.00	2.14	3.75	2.50	2.50	2.14	1.76	2.00
1.30	2.17	2.32	4.06	2.71	2.71	2.32	1.91	2.17
1.40	2.33	2.50	4.37	2.92	2.92	2.50	2.06	2.33
1.50	2.50	2.68	4.69	3.12	3.12	2.68	2.21	2.50
1.60	2.67	2.86	5.00	3.33	3.33	2.86	2.35	2.67
1.70	2.83	3.04	5.31	3.54	3.54	3.04	2.50	2.83
1.80	3.00	3.21	5.62	3.75	3.75	3.21	2.65	3.00
1.90	3.17	3.39	5.94	3.96	3.96	3.39	2.79	3.17
2.00	3.33	3.57	6.25	4.17	4.17	3.57	2.94	3.33
2.10	3.50	3.75	6.56	4.37	4.37	3.75	3.09	3.50
2.20	3.67	3.93	6.87	4.58	4.58	3.93	3.24	3.67
2.30	3.83	4.11	7.19	4.79	4.79	4.11	3.38	3.83
2.40	4.00	4.29	7.50	5.00	5.00	4.29	3.53	4.00
2.50	4.17	4.46	7.81	5.21	5.21	4.46	3.68	4.17
Bushels per 100 pounds.	1.667	1.786	3.125	2.083	2.083	1.786	1.471	1.667
Bushels per ton.....	33⅓	35⅝	62½	41⅔	41⅔	35⅝	29 7/17	33⅓

HOW TO USE TABLE III.

The use of Table III can be well illustrated by examples. Given $2.50 as the value of 100 pounds of barley, what is the corresponding value per bushel? Look for $2.50 in column headed "Value per 100 pounds, barley." Opposite this value in column "Value per bushel" is given the corresponding value of barley per bushel, which is $1.20.

RELATIVE VALUE OF FEEDS.

The selling price of a feed is not a reliable guide to its relative feeding value. The carbohydrate feeds (corn, oats, barley, kafir, and various others) and the protein feeds (cotton-seed meal, tankage, and brewers' grains) are found on the market at various prices. The feeder wants to know, with certain given prices, "What is the cheapest feed to buy—what is the true value of a bushel of oats, rye, or barley for feed when corn is worth 80 cents a bushel, or what is the value of a ton of brewers' grains, linseed meal, or bran when cotton-seed meal is worth $30 per ton and corn a dollar a bushel?" In the following pages there are presented tables, by the use of which these questions can be answered.

RELATIVE VALUE OF PROTEIN FEEDS.

In localities in which the cheapest and most available feeding stuffs are deficient in protein and where, in consequence, it is necessary to buy nitrogenous concentrates as a means of balancing the ration, the feeder's problem is to obtain the needed protein with the smallest possible outlay of money. The method here outlined shows how this may be done.

TABLE IV.—*To determine the relative cost of one pound of digestible protein in the protein feeds.*

											Pounds per ton digestible—		Proportional digestible protein.	Excess protein.
											Carbohydrate.	Protein.		
Value of corn per bushel, shelled	$0.40	$0.45	$0.50	$0.55	$0.60	$0.65	$0.70	$0.75	$0.80	$0.90	$1.00	.....	.....	.....	.....
Value of corn per ton, shelled, 35⅘ bushels	14.29	16.07	17.86	19.65	21.43	23.21	25.00	26.79	28.58	32.14	35.71	1,538	138	.....	.....
	Values, per ton, of corn containing similar amounts of carbohydrates and proportioned protein.														
I. Concentrate protein feeds:															
Brewers' grains, dried	$8.21	$9.24	$10.26	$11.30	$12.32	$13.34	$14.37	$15.40	$16.42	$18.48	$20.53	884	430	79	351
Cottonseed meal, choice	7.66	8.61	9.57	10.53	11.49	12.43	13.40	14.35	15.30	17.22	19.14	824	740	74	666
Cottonseed meal, good	8.03	9.03	10.03	11.04	12.04	13.04	14.05	15.05	16.04	18.06	20.06	864	632	78	554
Cowpea seed	10.60	11.91	13.23	14.57	15.89	17.20	18.54	19.86	21.17	23.83	26.47	1,140	388	102	286
Distillers' grains, dry, corn	12.36	13.90	15.44	17.00	18.54	20.07	21.63	23.17	24.72	27.80	30.88	1,330	448	119	329
Distillers' grains, dry, rye	9.81	11.04	12.26	13.49	14.72	15.93	17.17	18.39	19.63	22.07	24.52	1,056	272	95	177
Dried blood	.37	.42	.46	.51	.56	.60	.65	.70	.74	.84	.93	40	1,382	4	1,378
Fish meal, high in fat	4.85	5.45	6.06	6.67	7.28	7.88	8.49	9.09	9.69	10.91	12.12	522	756	47	709
Fish meal, low in fat	.93	1.04	1.16	1.28	1.39	1.51	1.63	1.74	1.86	2.09	2.32	100	818	10	808
Germ oil meal (L. G.)	13.53	15.22	16.90	18.61	20.30	21.97	23.67	25.36	27.07	30.43	33.81	1,456	200	131	69
Germ oil meal (H. G.)	12.26	13.79	15.32	16.87	18.40	19.92	21.46	23.00	24.54	27.59	30.65	1,320	330	118	212
Gluten feed (H. G.)	10.98	12.35	13.72	15.10	16.48	17.84	19.22	20.59	21.95	24.71	27.45	1,182	432	106	326
Gluten feed (L. G.)	12.75	14.34	15.93	17.53	19.12	20.70	22.31	23.90	25.48	28.68	31.86	1,372	302	123	179
Linseed meal (N. P.)	8.21	9.24	10.26	11.30	12.32	13.34	14.37	15.40	16.42	18.48	20.53	884	634	79	555
Linseed meal (O. P.)	8.86	9.97	11.07	12.19	13.30	14.40	15.51	16.62	17.72	19.94	22.15	954	604	86	518
Malt sprouts	9.35	10.51	11.68	12.86	14.02	15.18	16.36	17.52	18.68	21.03	23.36	1,006	406	90	316
Meat and bone meal, 30-40 per cent ash	4.61	5.18	5.76	6.34	6.91	7.48	8.06	8.64	9.21	10.37	11.52	496	740	44	696
Meat and bone meal, over 40 per cent ash	4.11	4.62	5.13	5.65	6.16	6.67	7.19	7.70	8.21	9.24	10.26	442	618	40	578
Peanuts, with hulls	16.50	18.53	20.59	22.67	24.67	26.77	28.85	30.90	32.98	37.08	41.19	1,774	368	159	209
Peanut cake, with hulled nuts	6.81	7.65	8.50	9.35	10.21	11.04	11.90	12.75	13.61	15.30	17.00	732	856	66	790
Rye middlings	11.62	13.06	14.51	15.97	17.42	18.86	20.32	21.77	23.21	26.13	29.02	1,250	252	112	140
Soy-bean seed	10.26	11.54	12.82	14.11	15.39	16.66	17.95	19.23	20.50	23.07	25.63	1,104	614	99	515
Tankage, 55–60 per cent	5.31	5.98	6.64	7.31	7.97	8.63	9.30	9.96	10.62	11.96	13.28	572	1,080	51	1,029
Tankage, 45–55 per cent	5.72	6.44	7.15	7.87	8.59	9.29	10.01	10.73	11.44	12.87	14.30	616	962	55	907
Tankage, below 45 per cent	6.99	7.86	8.73	9.61	10.48	11.35	12.23	13.10	13.97	15.72	17.46	752	752	67	685
Velvet-bean seed	11.70	13.10	14.55	16.03	17.40	18.92	20.39	21.84	23.31	26.21	29.12	1,254	362	113	249
Wheat flour middlings	11.61	13.06	14.51	15.97	17.42	18.86	20.32	21.77	23.21	26.13	29.02	1,250	314	112	202
Wheat bran, winter	8.81	9.91	11.01	12.12	13.22	14.30	15.41	16.51	17.61	19.81	22.01	948	244	85	159
Wheat short, standard wheat middlings	10.39	11.68	12.98	14.29	15.58	16.87	18.18	19.46	20.76	23.37	25.96	1,118	268	100	168

TABLE IV.—*To determine the relative cost of one pound of digestible protein in the protein feeds*—Continued.

	Values, per ton, of corn containing similar amounts of carbohydrates and proportioned protein.											Pounds per ton digestible—		Proportional digestible protein.	Excess protein.
												Carbohydrate.	Protein.		
II. Roughage protein feeds:															
Alfalfa hay	7.62	8.57	9.52	10.48	11.43	12.37	13.33	14.27	15.23	17.14	19.04	820	212	74	138
Alfalfa meal	7.53	8.46	9.40	10.35	11.29	12.22	13.17	14.11	15.01	16.93	18.81	810	204	73	131
Clover hay, alsike	7.32	8.23	9.15	10.07	10.98	11.89	12.81	13.73	14.65	16.47	18.30	788	158	71	87
Clover hay, crimson	7.25	8.15	9.06	9.97	10.87	11.77	12.68	13.59	14.50	16.30	18.11	780	194	70	124
Clover hay, red	8.05	9.05	10.05	11.07	12.07	13.07	14.08	15.08	16.10	18.10	20.11	866	152	78	74
Clover hay, sweet	6.88	7.73	8.59	9.46	10.32	11.17	12.03	12.89	13.76	15.47	17.18	740	200	66	134
Clover hay, sweet, white	8.68	9.76	10.85	11.94	13.02	14.09	15.19	16.27	17.36	19.52	21.69	934	236	84	152
Cowpea hay, all analyses	6.67	7.50	8.34	9.18	10.01	10.83	11.67	12.51	13.33	15.01	16.67	718	262	64	198
Molasses, alfalfa feeds	7.82	8.80	9.78	10.76	11.74	12.70	13.69	14.66	15.64	17.60	19.55	842	170	76	94
Peanut-vine hay with nuts	10.83	12.19	13.54	14.90	16.25	17.60	18.96	20.31	21.67	24.37	27.07	1,166	192	105	87
Peas and oat hay	2.23	2.51	2.79	3.07	3.34	3.62	3.90	4.18	4.46	5.02	5.57	240	48	21	27
Skim milk, centrifugal	1.02	1.15	1.28	1.41	1.53	1.66	1.79	1.92	2.04	2.29	2.55	110	72	10	62
Soy-bean hay	7.79	8.76	9.73	10.71	11.68	12.65	13.63	14.60	15.56	17.52	19.46	838	234	75	159
Velvet-bean hay	8.08	9.09	10.10	11.12	12.13	13.13	14.15	15.15	16.17	18.18	20.20	870	240	78	162
Vetch hay	8.62	9.70	10.77	11.86	12.94	14.00	15.09	16.17	17.25	19.40	21.55	928	232	83	149

NOTE.—It was necessary to include the fat with its usual equivalent value (2¼ times carbohydrate) with the carbohydrates, in order to devise Tables IV and V. Reference: Table III, Digestible nutrients and fertilizing constituents, Henry's "Feeds and Feeding."

As seen in Table IV, a ton of corn contains 1,538 pounds of carbohydrates and 138 pounds of protein, or 0.0897 pounds of protein for each pound of carbohydrates. Hereafter, in the discussion of this table, this 0.0897 pound of protein to each pound of carbohydrates is referred to as "proportional protein." It is the proportion of protein accompanying carbohydrates in corn.

A ton of dried brewers' grains contains 884 pounds of carbohydrates and 430 pounds of protein. Now, in corn, 884 pounds of carbohydrates would be accompanied by 79 pounds of protein ($884 \times 0.097 = 79$). The nutrients in a ton of dried brewer's grains may thus be classified as follows:

	Pounds.
Carbohydrates, 884 pounds, proportional protein	79
excess protein	351
Total protein	430

The digestible carbohydrate content of a ton of each of the various protein feeds is given in Table IV, first column to the right of the double rule. The digestible protein per ton is given in the next column. This is the sum of the proportional protein, given in next to the last column, and the excess protein, given in the last column. The proportional protein in choice cottonseed meal, for instance, which is 74 pounds, merely represents the protein obtained in corn along with 824 pounds of carbohydrates, which is the amount of the latter contained in a ton of choice cotton seed meal.

The method here outlined is based on the assumption that the carbohydrates and "proportional protein" in a ton of any expensive protein feed are worth just what they would cost in the cheap and standard carbohydrate feed used as a basis of comparison (corn in Table IV).

The first 11 columns of figures in Table IV give the value of the carbohydrates and proportional protein in a ton of each of the various nitrogenous feeds when the price of corn is as shown in the column headings.

When corn is worth more than a dollar a bushel, the value of the carbohydrate and proportional protein given in Table IV may be easily obtained by either combining the figures given in two columns or by adding to the values given in one column a proportional part of the values given in another. For example, when corn is worth $1.50 a bushel, double the amounts given in column headed "$0.75"; when it is worth $1.15 a bushel add to the values given in column headed "$1.00" one-third the amount given in column headed "$0.45."

To illustrate the method of arriving at the cost of a pound of excess protein, let us assume that corn is 60 cents a bushel and peanut cake is $30 a ton. In the column headed "$0.60" we find

that when corn is 60 cents per bushel the carbohydrates and proportional protein in a ton of peanut cake are worth $10.21. The excess protein in a ton of cake thus costs $30 − $10.21 = $19.79. Since there are 790 pounds of this excess protein, a single pound costs $19.79 ÷ 790 = $0.025, or 2.5 cents.

A few additional problems will show the facility with which computations may be made by use of this table.

1. Corn is available at 60 cents a bushel. Choice cottonseed meal can be bought at $32 a ton and high-grade gluten feed at $24. Which of the latter is the cheaper source of protein?

Solution:

Cottonseed meal.	Gluten feed.
$32.00	$24.00
[1] 11.49	[1] 16.48
[2] 666) 20.51	[2] 326) 7.56
0.0308	0.0232

Hence, gluten feed, under the conditions named, is the cheaper source of protein. It furnishes this element at 2.32 cents per pound, as against 3.08 cents for cottonseed meal.

In case the price of corn is not given exactly in the table, use the nearest price given. In this case the result will not be exact, but the inaccuracy will be of such nature that the result is never misleading.

2. With corn at 80 cents a bushel, choice cottonseed meal $45 per ton, and tankage (45–55 per cent) $50 per ton, which of the latter furnishes protein more cheaply?

Solution:

Cottonseed meal.	Tankage.
$45.00	$50.00
15.30	11.44
666) 29.70	907) 38.56
0.0446	0.0425

The $15.30 and $11.44 in the above solution are taken from Table IV, column headed "$0.80"; the 666 and 907 are taken from the last column. Tankage is seen to be the cheaper source of protein at the prices given.

HOW TO USE TABLE IV.

Given a certain number of protein feeds with the local selling prices per ton, to determine the relative cost of protein per pound, proceed as follows:

1. In columns headed "Value of corn per bushel" select the one corresponding most nearly to the local market price of that grain.

2. In that column take the amount found opposite the name of the feed in question and subtract it from the local selling price of that feed. The difference represents the value of the excess carbohydrate.

[1] From column headed $0.60 in Table IV. This figure is the value of the carbohydrates and proportional protein in a ton of the feed in question.

[2] From last column of Table IV. Pounds of excess protein in a ton of this feed.

3. In the last column opposite the name of the feed is given the amount of excess protein in a ton. Divide the value obtained above by this amount and the result is the value of a pound of excess protein, when bought in the feed considered.

RELATIVE VALUE OF CARBOHYDRATE FEEDS WHEN THE CHEAPEST AVAILABLE FEED IS NITROGENOUS.

In some sections of the country the most available feeding stuff is distinctly nitrogenous in character, and it is desirable to buy carbonaceous feeding stuffs to balance the ration. Thus, in the South, cottonseed meal is frequently the basic feeding stuff, while in many parts of the West alfalfa occupies this position. In such cases it becomes desirable to know the cheapest available source of carbohydrates. The method of procedure is given in the following pages. It is similar to that already given for evaluating protein feeds.

As seen in Table V a ton of choice cottonseed meal contains 740 pounds of digestible protein and 824 pounds of digestible carbohydrate, or 1.113 pounds of carbohydrate for each pound of protein. Hereafter, in the discussion of this table, this 1.113 pounds of carbohydrate to each pound of protein is referred to as "proportional carbohydrate." It is the proportion of carbohydrates accompanying protein in cottonseed meal.

A ton of barley contains 180 pounds of protein and 1,408 pounds of carbohydrate. Now, in cottonseed meal, 180 pounds of protein would be accompanied by 200 pounds of carbohydrate ($180 \times 1.113 = 200$). The nutrients in a ton of barley may thus be classified as follows:

	Pounds.
Proteins 180 pounds, proportional carbohydrates	200
excess carbohydrates	1,208
Total carbohydrates	1,408

The digestible protein content of a ton of each of the various carbohydrate feeds is given in Table V, first column to the right of the double rule. The digestible carbohydrate per ton is given in the next column. This is the sum of the proportional carbohydrate, given in next to the last column, and the excess carbohydrate, given in the last column. The proportional carbohydrate in dry beet pulp, for instance, which is 102 pounds, merely represents the carbohydrate obtained in cottonseed meal along with 92 pounds of protein, which is the amount of the latter contained in a ton of dry beet pulp.

The method here outlined is the same as that for Table IV. It is based on the assumption that the protein and the proportional carbohydrate in a ton of any expensive carbohydrate feed are worth just what they would cost in the cheap protein feed used as a basis of comparison (cottonseed meal in Table V).

TABLE V.—*To determine the relative cost of 1 pound of digestible carbohydrate in carbohydrate feeds.*

								Pounds per ton digestible—		Proportional carbohydrates.	Excess carbohydrates.
								Protein.	Carbohydrates.		
Value of cottonseed meal per ton [1]	$10.00	$15.00	$20.00	$25.00	$30.00	$35.00	$40.00	740	824	.....	.....
	Values per ton of cottonseed meal containing similar amounts of protein (and proportional carbohydrates).										
Barley	2.43	3.65	4.87	6.08	7.30	8.51	9.73	180	1,408	200	1,208
Beet pulp, dry	1.24	1.86	2.49	3.11	3.73	4.35	4.97	92	1,340	102	1,238
Broom-corn seed	2.24	3.36	4.49	5.61	6.73	7.85	8.97	166	1,374	185	1,189
Buckwheat	2.19	3.28	4.39	5.47	6.57	7.66	8.76	162	1,106	180	926
Corn, shelled	1.86	2.80	3.73	4.66	5.59	6.53	7.46	138	1,538	154	1,384
Corn and cob meal	1.65	2.47	3.30	4.12	4.94	5.77	6.59	122	1,440	136	1,304
Corn, oats, and barley feed	2.46	3.69	4.93	6.15	7.38	8.61	9.84	182	1,378	203	1,175
Durra grain	2.22	3.32	4.44	5.54	6.65	7.76	8.86	164	1,480	183	1,297
Germ oil meal (high grade)	2.70	4.05	5.41	6.76	8.11	9.46	10 81	200	1,456	223	1,233
Germ oil meal (low grade)	4.46	6.69	8.93	11.15	13.38	15.61	17.84	330	1,320	367	953
Gluten feed (high grade)	5.84	8.76	11.69	14.59	17.51	20.43	23.35	432	1,182	481	701
Hominy feed (high grade)	1.89	2.84	3.79	4.73	5.67	6.62	7.57	140	1,552	156	1,396
Hominy feed (low grade)	1.70	2.55	3.41	4.26	5.11	5.96	6.81	126	1,534	140	1,394
Kafir grain	2.43	3.65	4.87	6.08	7.30	8.51	9.73	180	1,420	200	1,220
Milo grain	2.35	3.53	4.71	5.88	7.05	8.23	9.40	174	1,424	194	1,230
Molasses cane	.27	.40	.54	.68	.81	.95	1.08	20	1,144	22	1,122
Molasses alfalfa feeds	2.30	3.45	4.60	5.74	6.89	8.04	9.19	170	842	189	653
Molasses feeds, below 10 per cent	2.22	3.32	4.44	5.54	6.65	7.76	8.86	164	1,168	183	985
Molasses feeds, 10-25 per cent	2.00	3.00	4.01	5.00	6.00	7.00	8.00	148	1,142	165	977
Oats	2.62	3.93	5.25	6.55	7.86	9.18	10.49	194	1,214	216	998
Oats, ground (high grade)	2.54	3.81	5.09	6.35	7.62	8.89	10.16	188	1,212	209	1,003
Rice bran	1.92	2.88	3.84	4.80	5.76	6.72	7.67	142	1,092	158	934
Rice, polished	2.16	3.24	4.33	5.40	6.48	7.57	8.65	160	1.482	178	1,304
Rice, rough	1.27	1.91	2.54	3.18	3.81	4.45	5.08	94	1,368	105	1,263
Rye	2.67	4.01	5.36	6.69	8.02	9.37	10.70	198	1,422	220	1,202
Rye meal	2.49	3.73	4.98	6.22	7.46	8.70	9.95	184	1,410	205	1,205
Sorghum, grain	2.03	3.04	4.06	5.07	6.08	7.10	8.11	150	1,440	167	1,273
Wheat, winter	2.35	3.53	4.71	5.88	7.05	8.23	9.40	174	1,420	194	1,226
Wheat bran, winter	3.30	4.94	6.61	8.24	9.89	11.54	13.19	244	948	272	676

[1] Composition based on choice cottonseed meal.

The first seven columns of figures in Table V give the value of the protein and proportional carbohydrate in a ton of the various carbohydrate feeds when the price of cottonseed meal is as shown in the column headings. When the value of cottonseed meal varies from that given in the column headings the value of protein and proportional carbohydrate can be made to correspond by increasing the figures in one of the columns a proportional amount. For instance, when cottonseed meal is worth $12 per ton the figures in column headed $10 should be increased by $\frac{1}{5}$, or 20 per cent.

To illustrate the method of arriving at the cost of a pound of excess carbohydrate let us assume that choice cottonseed meal is $35 and dried beet pulp $15 per ton. In the column headed "$35.00" we find that when cottonseed meal is $35, the protein and proportional carbohydrate in a ton of dried beet pulp are worth $4.35. The excess carbohydrate in a ton of beet pulp thus costs $15 − $4.35 = $10.65. Since there are 1,238 pounds of this excess carbohydrate, a single pound costs $10.65 ÷ 1,238 = 0.86 cents. A few additional problems will show the ease with which computations may be made by use of this table.

Problem 1.—Choice cottonseed meal is available at $35 per ton. Sorghum grain can be bought at $20, rough price at $28, and shelled corn at $30.35, or 85 cents per bushel. Which is the cheapest source of carbohydrate?

Solution:

Sorghum grain.	Shelled corn.	Rough rice.
$20.00	$30.35	$28.00
[1] 7.10	[1] 6.53	[1] 4.45
[2] 1273) 12.90	[2] 1384) 23.82	[2] 1263) 23.55
0.0101	0.0172	0.0186

Problem 2.—Given cottonseed meal at $30 per ton and shelled corn at 95 cents per bushel, what is the value per ton of barley, oats, and rye for balancing a cottonseed meal ration?

Solution:

$33.92	(Value of ton of corn at 95 cents per bushel. See Table III.)
5.59	(See Table V, column headed $30, opposite corn, shelled.)
1384) 28.33	(For 1384, see last column Table V, opposite corn, shelled.)
0.0204	(Value of a pound of excess carbohydrates in corn.)

Barley: A ton of barley contains 1,208 pounds of excess carbohydrates, which, at 2.04 cents per pound, is worth $24.64.[3] The protein and the remaining carbohydrates are worth $7.30. (See Table V, column headed "$30.00," opposite barley.) Hence,

[1] See column headed "$35.00" (Table V). These figures represent the value of the protein and proportional carbohydrate in a ton of these feeds when cottonseed meal is worth $35 per ton.

[2] See last column, Table V.

[3] It is assumed that a pound of excess digestible carbohydrate has the same value regardless of the feed which supplies it. When cottonseed meal is worth $30 and corn 95 cents, a pound of excess carbohydrate has a value of 2.04 cents. This figure is used for determining the value of the excess carbohydrate in oats and rye. The value of the remaining carbohydrate content and the protein in these feeds is taken from Table V.

under the conditions named, a ton of barley is worth $24.64 + $7.30 = $31.94. In a like manner the value of a ton of oats and rye are obtained:

Oats:	998×0.0204=$20.36	
	7.86	
	28.22	(Value of a ton of oats.)
Rye:	1202×0.0204= 24.52	
	8.02	
	32.54	(Value of a ton of rye.)

The value of each of these grains per bushel is now easily found from Table III to be as follows: Barley, 77 cents; oats, 45 cents; rye, 91 cents.

HOW TO USE TABLE V.

Given a certain number of carbohydrate feeds with the local selling prices per ton, to determine the relative cost of excess carbohydrate per pound, proceed as follows:

(1) In columns headed "Value of cottonseed meal" select the one corresponding most nearly to the local market price of that feed.

(2) In that column take the amount found opposite the name of the feed in question and subtract it from the local selling price of that feed. The difference represents the cost of the excess carbohydrate.

(3) In the last column opposite the name of the feed is given the amount of excess carbohydrate in a ton. Divide the value obtained above by this amount and the result is the cost of a pound of excess carbohydrate when bought in the feed considered.

In many sections of the West and Southwest alfalfa hay is the basic feeding stuff. It is distinctly nitrogenous in character, and it is often desirable to buy carbonaceous feeding stuffs to balance the ration. The method of procedure is the same as that already given in connection with Table V.

As seen in Table VI, a ton of alfalfa hay contains 212 pounds[1] of digestible protein and 820 pounds[1] of digestible carbohydrates, or 3.868 pounds of carbohydrates for each pound of protein. Hereafter in the discussion of this table this 3.868 pounds of carbohydrates to each pound of protein is referred to as "proportional carbohydrates." It is the proportion of carbohydrates accompanying protein in alfalfa hay.

A ton of barley contains 180 pounds of protein, and 1408 pounds of carbohydrates. Now, in alfalfa hay, 180 pounds of protein would be accompanied by 696 pounds of carbohydrates (180 × 3.868 = 696). The nutrients in a ton of barley may thus be classified as follows:

	Pounds.
Protein 180 pounds, proportional carbohydrates	[1] 696
excess carbohydrates	[1] 712
Total carbohydrates	[1] 1,408

[1] See Table VI, last four columns opposite names of feeds in question, for the distribution of the nutrients in a ton of each.

The proportional carbohydrate in barley, for instance, which is 696 pounds, merely represents the carbohydrates obtained in alfalfa hay along with 180 pounds of protein, which is the amount of the latter contained in a ton of barley.

As previously stated, the method here outlined is based on the assumption that the protein and "proportional carbohydrates" in a ton of any expensive carbohydrate feed are worth just what they would cost in the cheap protein feed used as a basis of comparison (alfalfa hay in Table VI).

The first 10 columns of figures in Table VI give the value of the protein and the proportional carbohydrates in a ton of the various carbohydrate feeds when the price of alfalfa hay is as shown in the column headings. Other figures to correspond to a different value of alfalfa hay may be easily obtained either by combining the figures of two columns in Table VI or by increasing those of one column by a proportional part of those in another column. For instance, when alfalfa is worth $7, increase the figures found in column headed "$6.00" by one-fourth of those found in column headed "$4.00" to get figures corresponding to alfalfa at $7.

To illustrate the method of arriving at the cost of a pound of excess protein let us assume that alfalfa hay is $10 per ton and barley is available at $22.88 a ton or 55 cents a bushel. In the column headed "$10.00" we find that when alfalfa is $10 per ton the protein and the proportional carbohydrate in a ton of barley is worth $8.49. The excess carbohydrate in a ton of barley thus costs $22.88 − $8.49 = $14.39. Since there are 712 pounds of excess carbohydrate, a single pound costs $14.39 ÷ 712 = $0.0202, or 2.02 cents.

The use of Table VI is further illustrated in the following problem:

Alfalfa hay is available at $12, shelled corn at $25, barley at $23, and milo grain at $24 a ton. Which of the three grains is cheapest as a source of carbohydrates for balancing an alfalfa ration?

Solution:

	Corn.	Barley.	Milo.
	$25.00	$23.00	$24.00
	[1] 7.81	[1] 10.19	[1] 9.85
	[2] 1004) 17.19	[2] 712) 12.81	[2] 751) 14.15
	[3] 0.0171	[3] 0.0180	[3] 0.01884

In this case, corn is the cheapest source of carbohydrates.

HOW TO USE TABLE VI.

Follow the directions given for the use of Table V.

[1] Table VI, column headed "$12.00," opposite corn, barley and milo. These figures represent the value of the protein and proportional carbohydrate in a ton of the feeds in question.

[2] Table VI, last column.

[3] Value of a pound of excess carbohydrates.

TABLE VI.—*To determine the relative cost of one pound of digestible carbohydrate in carbohydrate feeds.*

	Values per ton of alfalfa hay containing similar amounts of protein and proportional carbohydrates.										Pounds per ton digestible—		Proportional carbohydrates.	Excess carbohydrates.
											Protein.	Carbohydrates.		
Value of alfalfa hay per ton[1]	$4.00	$6.00	$8.00	$10.00	$12.00	$15.00	$18.00	$20.00	$25.00	$30.00	212	820	.....	.....
Barley	$3.40	$5.09	$6.79	$8.49	$10.19	$12.74	$15.28	$16.98	$21.22	$25.47	180	1,408	696	712
Beet pulp, dry	1.74	2.60	3.47	4.34	5.21	6.51	7.81	8.68	10.85	13.02	92	1,340	356	984
Buckwheat	3.06	4.58	6.11	7.64	9.17	11.47	13.76	15.28	19.10	22.92	162	1,106	627	479
Broom corn seed	3.13	4.70	6.27	7.83	9.40	11.75	14.10	15.66	19.57	23.49	166	1,374	642	732
Corn, shelled	2.60	3.91	5.21	6.51	7.81	9.77	11.72	13.02	16.27	19.53	138	1,538	534	1,004
Corn and cob meal	2.30	3.45	4.60	5.75	6.91	8.64	10.36	11.51	14.38	17.26	122	1,440	472	968
Corn, oat, and barley feed	3.43	5.15	6.87	8.58	10.30	12.88	15.45	17.17	21.46	25.75	182	1,378	704	674
Durra, grain	3.09	4.64	6.19	7.74	9.28	11.61	13.92	15.47	19.34	23.20	164	1,480	634	846
Germ oil meal (H. G.)	3.77	5.66	7.55	9.43	11.32	14.16	16.98	18.87	23.58	28.30	200	1,456	774	682
Germ oil meal (L. G.)	6.23	9.34	12.45	15.56	18.68	23.36	28.02	31.13	38.90	46.69	330	1,320	1,276	44
Hominy feed (H. G.)	2.64	3.96	5.28	6.60	7.92	9.81	11.89	13.21	16.50	19.81	140	1,552	542	1,010
Hominy feed (L. G.)	2.38	3.57	4.75	5.94	7.13	8.92	10.70	11.89	14.86	17.83	126	1,534	487	1,047
Kafir grain	3.40	5.09	6.79	8.49	10.19	12.74	15.28	16.98	21.22	25.47	180	1,420	696	724
Milo grain	3.28	4.92	6.57	8.21	9.85	12.32	14.77	16.42	20.51	24.62	174	1,424	673	751
Molasses cane or blackstrap	.38	.57	.75	.94	1.13	1.42	1.70	1.89	2.36	2.83	20	1,144	77	1,067
Molasses feeds below 10 per cent fiber	3.09	4.64	6.19	7.74	9.28	11.61	13.92	15.47	19.34	23.20	164	1,168	534	634
Molasses feeds 10–15 per cent fiber	2.79	4.19	5.59	6.98	8.38	10.48	12.57	13.96	17.45	20.94	148	1,142	572	570
Molasses alfalfa feeds	3.21	4.81	6.41	8.02	9.62	12.03	14.43	16.04	20.04	24.05	170	842	657	185
Oats, ground (H. G.)	3.55	5.32	7.10	8.87	10.64	13.31	15.96	17.74	22.16	26.60	188	1,212	727	485
Oats	3.66	5.49	7.32	9.15	10.98	13.73	16.47	18.30	22.87	27.45	194	1,214	750	464
Rice, rough	1.77	2.66	3.55	4.43	5.32	6.65	7.98	8.87	11.08	13.30	94	1,368	364	1,004
Rice, polished	3.02	4.53	6.04	7.55	9.06	11.32	13.58	15.10	18.86	22.64	160	1,482	619	863
Rice, bran	2.68	4.02	5.36	6.70	8.04	10.05	12.06	13.40	16.74	20.09	142	1,092	549	543
Rye	3.74	5.60	7.47	9.34	11.20	14.01	16.81	18.68	23.34	28.02	198	1,422	766	756
Rye meal	3.47	5.21	6.94	8.68	10.42	13.02	15.62	17.36	21.69	26.04	184	1,410	712	698
Sorghum, grain	2.83	4.24	5.66	7.07	8.49	10.62	12.74	14.15	17.68	21.22	150	1,440	580	860
Wheat, winter	3.28	4.92	6.57	8.21	9.85	12.32	14.77	16.42	20.51	24.62	174	1,420	673	747
Wheat bran, winter	4.60	6.91	9.21	11.51	13.81	17.27	20.72	23.02	28.77	34.52	244	948	944	4

[1] Composition based on all analyses.

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